The Feldstein-Horioka puzzle and capital mobility: The role of the recent crisis

Abstract

The Feldstein-Horioka puzzle has long been debated as it relates to the important topics of capital mobility and how to determine levels of investment. Adopting a recursive approach and panel techniques, this paper explores the impacts of the recent financial crisis on the validity of the puzzle. The OECD's saving-investment correlation dropped to a record low just before the 2007/08 crisis began, reflecting the perceived 'end' of the FH puzzle in some studies. But since the onset of the crisis, our results indicate that this correlation has increased, suggesting the puzzle's return. The puzzle for net capital-importing and net capital-exporting countries differs, with the relationship being more significant for the exporters compared to the importers, reflecting the asymmetry in terms of the degree of any shocks across countries.

Keywords: Feldstein-Horioka puzzle; capital mobility; financial crisis.

JEL classification: C23, F21, F32, F38.

1. Introduction

Capital mobility is central to open-economy macroeconomics following the removal of capital controls in many countries during the 1970s and 1980s. Feldstein and Horioka (FH hereafter, 1980) investigated this phenomenon and found an unexpectedly high correlation between domestic saving and investment rates. These results led FH (1980) to conclude that there was low capital mobility among OECD economies. The paper soon became a puzzle as it contradicts the traditional wisdom of relatively high capital mobility among developed countries.

The voluminous literature that has sprung up as a result reflects, in part, the important implications that the puzzle has on government policy. First, if capital mobility is low, much of the increase in saving would be re-invested domestically (Feldstein, 1983; Schmidt-Hebbel et al., 1996; Coakley et al., 1998). So governments might provide more incentives to encourage saving. Second, in the absence of measurement errors, the difference between domestic saving and investment mirrors the current account balance. A high saving-retention coefficient may therefore reflect governments' targeting of a current account balance (Obstfeld, 1986; Roubini, 1988; Summers, 1988; Coakley et al., 1996; Taylor, 2002). Third, since the onset of the recent financial crisis, there has been repatriation of international capital back to domestic countries. This repatriation of finance may have affected the way in which saving and investment move across countries and as a relatively new theme, this has not as yet become apparent in the literature.

This paper aims to contribute to the literature by investigating the role of the 2008 financial crisis in the puzzle's development. Specifically, this paper asks the following questions: Is the FH puzzle still a puzzle? Did the recent financial crisis affect the puzzle's

validity in the OECD and are the effects asymmetric across OECD countries? The last two questions have not as far as we know been attempted in the literature yet. This paper argues that the answer to all of the above is yes, and that the puzzle has returned post crisis. This has important policy implications. The rest of this paper is as follows. Section 2 reviews the literature. Section 3 sets out the methodology. Section 4 discusses the results and Section 5 concludes with a policy discussion.

2. Literature review

In a world of perfect capital mobility, saving should be invested to ensure the highest return, regardless of geographical location. Hence, there should be a low correlation between domestic saving and investment rates. FH (1980) challenged this post-war consensus by estimating the equation:

$$(I/Y)_i = \alpha + \beta(S/Y)_i \quad \textbf{(1)}$$

where I, S and Y respectively denote investment, saving, and GDP of country i.

In this cross-sectional model, β is the saving-retention coefficient. It measures how much domestic saving is retained for domestic investment. FH (1980) tested the model for OECD countries over the period 1960-74 and found that β was greater than 0.85 on average. This contradicts the post-World War II notion that capital mobility had improved among developed countries. Referred to in many subsequent studies as the FH puzzle, Obstfeld and Rogoff (2000, p.175) coined the seminal work "the mother of all puzzles".

2.1 – Empirical evidence for OECD countries

Murphy (1984) re-investigated the saving-retention coefficient using a sample of 17 OECD countries over 1960-80. Sample countries were divided into big and small groups according to their investment shares. Using a cross-sectional approach, small countries were found to display lower coefficients (0.57-0.59). The group as a whole, nevertheless, exhibited strong saving-investment correlation. For Murphy (1984), the FH model is a joint test for both capital mobility and that countries are small relative to the group. His results questioned the robustness of FH's (1980) findings across all countries. Feldstein and Bacchetta (1991) extended the sample period to 1960-86 and expanded the sample to 23 OECD countries. While robust, the saving-retention coefficients showed signs of declining. Many other FH-related studies largely confirmed the presence of the puzzle among OECD countries (Feldstein, 1983; Obstfeld, 1995; Armstrong et al., 1996; Coakley et al., 1996; Abbott and De Vita, 2003; Schmidt, 2003; Georgopoulos and Hejazi (2005); Narayan, 2005; Fouquau et al., 2008).

Georgopoulos and Hejazi (2005) formalised the assessment of the decline of β, by adding a time interaction term to the pooled version of FH's (1980) model:

$$\left(I/Y\right)_{it} = \alpha + \beta\left(S/Y\right)_{it} + \delta\left[\left(S/Y\right)_{it} * t\right] + u_{it} \qquad \textbf{(2)}$$

where t is time period of 1 to 31 years (1970-2000).

Saving retention is thus measured by $(\beta + \delta t)$ instead of β in FH's (1980) sense. δ was found to be negative and highly significant, meaning capital mobility was indeed increasing over time. Blanchard and Giavazzi (2002) observed that there were enduring current

account imbalances in Europe and re-tested FH's (1980) model using a sample of OECD, EU and euro-area countries. For euro-area sample countries, the saving-retention coefficient dropped from 0.41 over 1975-90 to 0.14 over 1991-2001. This followed the policy of encouraging the free movement of capital within the euro area. Whilst confirming the FH puzzle among OECD countries, Blanchard and Giavazzi (2002) claimed the end of the puzzle from a euro area's perspective. However, the puzzle's disappearance in the euro area was shown to be ephemeral by Johnson and Lamdin (2013). They took a sample of 17 euro-area and 10 other European countries. An event-driven approach indicated the Euro crisis began in 2006. They then tested whether capital mobility had reduced as a result. The coefficient was found to be positive and significant, translating to a 12% increase compared to the β obtained in the base case scenario.

2.2 – Alternative approaches to FH (1980)

An emerging consensus in the literature is that ignoring structural breaks in the saving and investment series tends to bias the saving-retention coefficient upwards (Kejriwal, 2008; Guzel and Ozdemir, 2011; Ketenci, 2012, 2013). For instance, Ketenci (2013) grouped his sample of OECD countries into EU15, countries in NAFTA agreements, and the G7. He established both saving and investment series to be I(1) variables, which satisfied the pre-requisite for conducting Hansen's (1992) stability test. Next, taking the p-values from the *MeanF*, Ketenci (2013) was able to distinguish between stable and unstable countries within each subgroup. Finally, Dynamic OLS (DOLS) estimators returned saving-retention coefficients of 0.75 and 0.86 for full G7 and stable G7 sample countries, respectively, whereas all other βs were below 0.49. Guzel and Ozdemir (2011) focused on Japan and the US and instead of sub-grouping, dummy variables were constructed for the endogenous break dates. Again, the βs displayed lower values compared to when the breaks were not accounted for.

Herwartz and Xu (2010) lent empirical support to the puzzle but offered caution regarding its interpretation with a functional model over the sample period 1972-2002. They also distinguished the stable short-run saving-retention coefficient from the long-run. The latter was found to be impacted by factors including government expenditure and exports, so that β, as in FH's (1980) sense, might not just capture capital mobility. A country size effect in the fashion of Murphy (1984) and Petreska and Mojsoska-Blazevski (2013) was again reported. Bai and Zhang (2010) attributed the low capital mobility established under FH's (1980) framework to potential financial frictions. They found that capital immobility appeared to be caused by the interaction of the two types of frictions: limited enforcement (through a default penalty) and limited spanning (non-contingent bonds).

Coakley et al. (1996) and Krol (1996) challenged the puzzle's existence using a long-run current account solvency constraint. For Krol (1996), the solvency constraint implied the current account averages would tend to zero. Therefore, cross-sectional regressions using averaged domestic saving and investment rates would likely over-estimate the saving-retention coefficient. From this perspective, panel regressions were deployed to estimate 21 sample OECD countries over the period 1962-90. Their results produced estimates of 0.2 and the low value of β led to the rejecting of the FH puzzle.

The inclusion of Luxembourg as a potential outlier has been a common criticism by Tesar (1991), Jansen (2000), and Coiteux and Olivier (2000). Re-examining the results without Luxembourg did yield very different conclusions in some cases. This prompted an admission of possible sample selection bias (Demetriades and Hussein, 1996). But Ho (2002), applying DOLS and Fully Modified OLS (FMOLS) estimators, arrived at low saving-retention coefficients, with and without Luxembourg, thus bucking the selection bias argument.

A further strand of the literature has concentrated on the time-varying nature of international capital mobility, in particular that it has changed according to policy regimes or

exchange rate systems. A number of studies including Ozmen and Parmaksiz (2003) as well as Kejriwal (2008) introduced various types of structural breaks to model the regime changes. Recently a new theme in the literature has used Markov switching models to account for the changes in regime. Telatar et al. (2007) assumed two regimes, one of which has high capital mobility, the other low mobility. In the high capital mobility regime it was assumed that the FH puzzle did not hold: it only held where there was low capital mobility. Their results suggested the FH puzzle was unstable and sensitive to policy regimes. Chen and Shen (2015) have also used the Markov switching approach and found evidence of the time-varying nature of this relationship, as the saving-retention coefficients moved between high and low capital mobility regimes. In addition they found the relationship varied across the countries in their sample, in particular members of the European Monetary System where capital was more mobile between member states, levels of saving were less of a constraint on investment after 1990 and 2000.

3. Methodology

This study first draws on the different crisis experiences among net capital-importing and net capital-exporting countries. It then investigates the time-varying saving-retention coefficients using recursive estimations. Three panel techniques – Pooled OLS, the Fixed Effects (FE) and the Random Effects (RE) – are subsequently employed to examine any asymmetry. There are two main advantages to using panel data. First, the crisis is not yet completely over, meaning the number of observations is limited. Panel data also enables higher efficiency and less bias (Baltagi, 2005). Second, as Gujarati and Porter (2009) pointed out, there is the likelihood of heterogeneity bias in countries and this individuality can be captured by employing FE and RE models, Bebczuk and Schmidt-Hebbel (2010) were the first to apply these methods to the FH puzzle.

3.1 – Data

The data is from 1980 to 2012 on an annual basis and all is taken from the IMF *WEO* database. Complete data on $^{I}/_{Y}$ and $^{S}/_{Y}$ for 27 out of 34 current OECD countries from 1980 to 2012 yields a balanced panel of 108 observations (4 years and 27 countries) for the post-crisis period (2009-2012).

3.2 – Recursive estimations

The time-varying β across the OECD are examined using recursive estimations. Kalman (1960) first derived recursive least squares within a state-space model. A β estimate is given at each point in time; by plotting the β time series, the evolution of the correlation can be traced out. In this model, the time-varying coefficient and also the unobservable state variable are assumed to follow an autoregressive process. The recursive system is then written into two equations for each country (Duncan and Horn, 1972). The first is an observation equation that models the relationship between the observable and unobservable state variables: $(^{I}/_{Y})_t = \alpha_t + \beta_t(^{S}/_{Y})_t + u_t$. The second is a dynamic state equation that describes the autoregressive process: $\beta_t = T_t\beta_{t-1} + \varepsilon_t$.

3.3 – Panel estimations: 5 years pre and post crisis

The panel techniques are employed to investigate the saving-investment correlation in the historical period (1980-2003), 5 years prior to (2004-08), and 5 years after the crisis (2008-12). A time-trend interaction term is added to the estimations, following Georgopoulos and Hejazi (2005) in (2). To ensure robust estimates, white-period standard errors are computed.

But as cross-period differences are already considered by dividing the sample period, FE and RE only look at cross-country heterogeneity as follows:

$$(I/Y)_{it} = c_i + \beta(S/Y)_{it} + u_{it} \quad \textbf{(3)}$$

where c_i is the specific intercept for each country i. c_i is reported as an average: $\sum_{i=1}^{n} \frac{c_i}{n}$.

Restrictions in addition to standard Gauss-Markov assumptions apply here. The FE model, for instance, requires $(S/Y)_i$ to be changing over time, which is true as suggested by our data. On the other hand, the RE model assumes $E[c_i|(S/Y)_i] = \alpha$ and thus rules out any correlation between the country-specific intercept and that country's saving rate. This is a key contrast to FE, which allows for such correlation (Wooldridge, 2013). In fact, if $E[c_i|(S/Y)_i] \neq \alpha$, only FE is unbiased whereas if $E[c_i|(S/Y)_i] = \alpha$, RE is more efficient.

Therefore, an important question is whether theoretically there is some correlation between the unobserved country heterogeneity and their saving rate. Such correlation is possible, but also difficult to determine *a priori*. Subsequently, the Hausman test is conducted to determine the relative suitability of FE and RE (Hausman, 1978). The test assumes the superiority of RE unless rejected by test-statistics. But a failure to reject can also mean that RE and FE estimates are close enough that it does not matter which one to choose. In computing p-values, ordinary coefficient covariance instead of robust standard errors is used, as the latter may be inconsistent with Hausman test variance calculation assumptions (Hoechle, 2007).

Finally, the same exercise is repeated for net capital-exporting and net capital-importing countries to compare the potential asymmetric effects of the recent financial crisis.β

4. Empirical results

This section discusses the cross-section averages and examines the net balance of capital exports/imports. The latter helps group countries according to their relative position of capital exporting/importing. This will play a key role in subsequent panel estimations. The first two numerical columns in Table 1a show the averages of the investment and saving rates. Korea appears to have the highest average investment and saving rates in the sample, 31.77% and 32.99% respectively. Domestic capital formation thus comes across as a substantial input into Korea's economy. This is especially true for the decade prior to the 1997 Asian financial crisis: Korea's investment rate was above 35% at all times and reached its apogee of 40% in 1991, the highest in the entire dataset.

Appearing at the other end of the spectrum is the UK. Not only does it have the lowest average investment and saving rates (17.43% and 15.95%, respectively), but up till the recent crisis (2005-08), the UK investment rate had also been among the lowest of its OECD peers. Similarly, the UK saving rate was among the lowest since the 90s, nearing the bottom end with other crisis-ridden states including Iceland, Greece and Portugal. This is in line with Blanchard and Giavazzi (2002) who showed the 'end' of the FH puzzle and argued for the continuation of current account imbalances in the region. The countries' saving rates stayed low beyond the early 2000s and continued as the crisis loomed. But the recent low saving rate is more likely due to lowered income.

The next column calculates the difference between the investment and saving rates. Perhaps not surprisingly, the same crisis-hit countries are the top three net importers of capital in the sample: Iceland has an average of 5.11% investment over its saving rate; Greece has 5.6% and Portugal has 6.26%. In contrast, Luxembourg, Norway and the Netherlands come across as the largest exporters of capital in the sample. The far right column of Table 1a indicates the resulting classification of the countries into capital exporters and importers.

Year-on-year, the majority of countries fluctuate between being a net capital-exporter and importer. This serves to remind us that grouping countries based on particular characteristics is a simplification, and thus conclusions drawn from this exercise should be viewed with caution. Nevertheless, some countries, notably Australia, Greece, New Zealand and the United States, have been consistently net capital-importers throughout the 33-year period, as shown in the first numerical column in Table 1b. As a group generally they have suffered more during the 2008 financial crisis, with 13 out of the 16 net capital-importing countries having investment rates exceeding saving rates for at least 22 of the 33 years in question.

The last two columns in Table 1b test for the equality of the means and medians between each country's investment and saving rates. The Satterthwaite-Welch test is a powerful non-parametric test for comparing I/Y and S/Y, and tests the null that the two have identical distributions with respect to the mean. The Wilcoxon/Mann-Whitney test also compares I/Y and S/Y, but tests for the equality of the median. On the whole, the two tests report similar results, mostly providing evidence against FH over the entire time span. Austria, Finland, France and Germany have a negligible balance of capital exporting below 1%. Their differences in the mean and median of investment and saving rates are also reported as insignificant. Ireland, despite its 1.67% net capital imports, is not rejected either by the two tests for mean and median equality. This suggests a higher level of volatility in Ireland's series.

What is apparent so far is the stark difference in the performance of net capital exporters and importers post crisis. Whether the crisis has asymmetrically affected β in these country groups is a key question to be addressed in Section 4.2. For panel estimation purposes, countries with a positive surplus of domestic investment over saving (Table 1a) are grouped as 'net capital-importing countries'. The rest are 'net capital-exporting countries'.

4.1 – Recursive estimation results

The time-varying β for each country is summarised in Figure 1. Over the sample period, the FH puzzle has abated somewhat. The majority of the sample countries have their Beta in 2012 lower than in 1980. But the magnitude of these estimates should be interpreted with care. They are not directly comparable to other studies such as Abbott and De Vita (2003) which adopted different approaches. That said, inferences can still be made regarding betas' trends. For example, Austria's β gradually declined from about 3 to 0.5. This implies that over the course of three decades, less of Austrian saving is reinvested domestically. Very similar patterns exist for Belgium, Canada, Denmark, Germany, Sweden and Turkey. Close panel results would be strong support for the findings.

Net capital-importing countries seem to have a more problematic experience compared to their capital-exporting counterparts. The time-varying Beta for Greece, for instance, was about 0.8 in 1999. In part, this reflects the widening current account imbalance of the country as documented by Blanchard and Giavazzi (2002). A much smaller part of Greece's investment was, in turn, financed by domestic capital than before. One possibility is the increase in investors' confidence in the country's prospect of delivering a high return. This seemingly supports the claim that the FH puzzle had faded away temporarily.

Since 2008 however, Greece's beta has reversed its trend. It has come back up to 0.4 in 2012. Although these results cannot compare to cross-section estimates directly, it is clear that more of Greece's investment is now funded by domestic saving. Other net capital-importing peers including Italy have had a similar trend, but not as obvious as Greece's. Interestingly, several other crisis-hit countries like Spain and Portugal have an upward trending β overall. This is further examined in the panel estimations to follow. Surprisingly for the UK

and the US, the time-varying saving-retention coefficients are little changed around the crisis. This comes across although the two economies suffered quite considerably in the recent crisis. The general picture in terms of the puzzle's validity for some of the net capital-exporting countries is mixed. Luxembourg and Norway, the two countries mentioned in Section 4.1, exhibit no definite trends in their β over time, except an early drop for Luxembourg. The same holds for Japan, apart from the fluctuations felt in the 1980s. The Japanese asset price bubble might have encouraged more of its national saving to be reinvested in the housing market. In fact, in the five years leading up to 1991 when asset prices began to fall, the saving-investment correlation went up gradually. But since then it has remained constant.

4.2 – Panel estimations for the OECD

Subsequent sections discuss in turn the panel estimation results for the OECD, net capital exporters and net capital importers. The section above provides further details on how to arrive at country groupings.

4.2.1 – Beta falling 1980-2003: matching recursive estimates

Panel estimates in Table 2 largely correspond to the previous recursive estimates, although there are exceptions such as France, the Netherlands and New Zealand[1]. Using Pooled OLS, β in the historical period is 0.57, which is statistically significant at 1%. This is close to the saving-investment correlation in the original sense of FH (1980). Already, our

[1] Although for some countries such as France, the Netherlands and New Zealand as well as Greece between 1980 and 2006 there appears to be little change in the value of beta across the data span, this suggests for them the F-H puzzle may not hold, however for most countries the change is more apparent. So the panel data results indicating the F-H puzzle has varied around the financial crisis may not hold individually in all the countries in the sample.

historical β is markedly below studies that investigated the issue using OECD data from 1960 to 1980 (Sachs et al., 1981; Sachs, 1983; Coakley et al., 1996). But equally interesting is the time trend interaction term. Albeit only -0.0066, it lowers over time the marginal effect of saving (MES), which is defined as:

$$MES = \frac{\partial (I/Y)_{it}}{\partial (S/Y)_{it}} = \frac{\partial \beta (S/Y)_{it}}{\partial (S/Y)_{it}} + \frac{\partial \delta (S/Y)_{it} * t}{\partial (S/Y)_{it}} = \beta + \delta t \qquad \textbf{(4)}$$

At year 2003, $t = 24$, so $MES = 0.57 - 0.0066 * 24 \approx 0.41$. This provides strong support for the decreasing correlation between domestic saving and investment over time, consistent with Younas and Chakraborty (2011). In part, this reflects the continuous enhancement of the financial markets and trade linkages that present investors with a wider set of foreign investment opportunities. In fact, FE and RE results tell a similar story in the historical period. The β is significantly lower than studies that looked at earlier periods, and the MES lowered to around 0.33 by 2003. Nevertheless, in the historical period, the Hausman test rejects RE estimate which returns a much lower R-squared than FE's. This suggests that FE may better capture cross-section heterogeneity that is likely to be correlated with saving rates.

4.2.2 – Beta below zero before crisis, reflecting soaring capital flows

Historical estimates are in line with Fouquau et al. (2008), Bai and Zhang (2010) and Petreska and Mojsoska-Blazevski (2013), underlying the trend of increasing capital mobility among OECD countries. Yet, this alone does not completely explain the soaring capital flows in the build-up to the crisis. Estimates for 2004-08 may give part of the answer to that. All

estimations strikingly report negative Betas. A theoretical explanation of this by Westphal (1983) is that high world interest rates induce high domestic interest rates. Domestic saving, in turn, is driven up, and investment would likely experience a decline. Again, the Hausman test favours FE which gives an R-squared significantly higher than both Pooled OLS and RE. The FE result has lost significance, as did other estimations to a lesser extent, suggesting that domestic saving no longer explained domestic investment in the pre-crisis , unlike the historical period.

The negative β supports the claim of Blanchard and Giavazzi (2002) that the FH puzzle had ended in the broader set of OECD countries. Indeed, not only was capital mobility much higher than in the previous two decades, but investors generally were less concerned about the risk and uncertainty of overseas investment. Another possibility is financial and capital account deregulation. Central bankers and governments around the world were generally more relaxed about capital inflows. Data from the Bank for International Settlements (BIS) suggests that gross capital inflows[2] surged from a little above 6% of GDP in 2003 to almost 20% in 2007, echoing the passing away of the FH puzzle.

4.2.3 – FH puzzle returns post crisis

Buoyant expectations on investment returns have reversed since the onset of the crisis, as have the β estimates. Pooled OLS and RE both report a dramatic pick-up in the saving-retention coefficient from below zero to above 0.7. They have also regained their statistical significance at the 1% level, being accompanied by a negative time-trend once more. Together with an OLS R-squared of 0.27, it is possible to infer a remarkably lower capital mobility post crisis. From 2004 through to 2008, domestic investment could not be meaningfully explained

[2] Measured as the sum of global net purchases of domestic assets by foreigners.

by domestic saving. But since 2008 about 70% of domestic investment has been channelled from domestic saving in the OECD. BIS data again resonates with the reappearance of the FH puzzle – global capital inflows have shrunk from nearly 20% to merely 2% of GDP in just one year to 2009.

This is, however, only one aspect of the story. It is also important to note that the biggest fall in both saving and investment rates was in 2008/09, amounting to 3-4% of GDP. Taken together with the increased saving-retention coefficient, we may suggest two characteristics of investors. First, investor confidence has suffered a huge decline since the crisis. This may reflect a much lower willingness to invest as a percentage of income. Second, investors' risk profiles shifted back to domestic countries. Clouded with international uncertainty, investors would now rather put a significant portion of their saving in their home economy, where withdrawal may be easier in the event of any tail risk materialising. From a macroprudential viewpoint, tightened regulation since the collapse of Lehman Brothers might have also discouraged foreign banks and other financial intermediaries from providing credit to the domestic economy. In the UK, for instance, lending growth from foreign bank branches fell much more than that from domestic banks (Hoggarth et al., 2013).

What is perhaps equally surprising is that beta has attained a level higher than the historical trend. While decades of financial integration should not have completely been reversed, domestic saving from national income seemed to be temporarily more invested at home compared to thirty years previously. The bottom line here is that capital mobility and thus the validity of the FH puzzle have altered. The puzzle 'disappeared' briefly prior to the crisis but then came back into the picture.

4.2.4 – Less capital volatility in net capital exporters pre and post crisis

The final question posed by this paper is addressed here. According to Table 3, the saving-retention coefficient for 2004-08 is not noticeably different for net capital-exporting countries compared to the OECD. The drop in beta estimates and their statistical significance similarly apply to this subgroup. A dramatic fall is seen across the board, with FE and RE both reporting a Beta of -0.21 though the Hausman test favours RE with a p-value of 0.39. However, since the beginning of the Great Recession, saving-retention coefficients rebounded to between 0.59-0.69 (Table 3). Qualifying the findings, the Hausman test again fails to reject RE in the post-crisis period, as is the case for the OECD. In OLS as well as in RE, evidence points to a less pronounced return of the FH puzzle for net capital-exporting countries, a signal that their capital mobility might not be as tumultuous as the OECD group. This might help explain why some of these countries have fared better than their net capital-importing counterparts.

4.2.5 – A more unsettling experience for net capital importers

For net capital-importing countries in Table 4, an observation regarding the historical and pre-crisis periods similar to the other groups is possible. In the build-up to 2008, pooled OLS, FE and RE estimates have all lost statistical significance, suggesting domestic saving is not related to domestic investment. Net capital-importing countries might be more successful in attracting foreign funds. Greece, for instance, sustained a widening current account balance up until 2009, indicating the FH puzzle had vanished for that period.

At the outset of the crisis however, a more troubling tale of volatility emerged. The consistently insignificant saving-retention coefficients pre crisis were perhaps a precursor of more drastic corrections to come. In 2008-12, the β for net capital-importing countries has reversed to above the OECD's, though not all results are in agreement. Table 4 shows beta

rose to 1.19 according to Pooled OLS and RE estimates, suggesting a 1% decrease in saving on average leads to a 1.19% decrease in investment. However the Hausman test indicates FE is the most appropriate model in this case, which produces an insignificant relationship. Across estimation methods, the R-squared is higher for net capital-importing countries than for the OECD in the post-crisis period. In part, this could be attributed to a deeper crisis of confidence among net capital-importing countries than their net capital-exporting peers. Investors might be more concerned about the high level of debt built up in the period of escalating capital flows.

This answers the last question of this paper – the impact of the crisis on the validity of the FH puzzle is likely to have been asymmetric. Net capital-exporting countries do not seem to have experienced a 'crisis' at all, with the saving-retention coefficient little changed around the crisis. On the contrary, net capital-importing countries have had a more unsettling experience. Their β dropped to a lower level compared to the OECD as a whole, and the setback was also more powerful.

5. Conclusion

According to the panel results, the OECD's saving-retention coefficient stands at a high post-crisis, albeit with a substantial decline from the historical period. There is also a good level of agreement from the recursive estimates. The crisis substantially affected the puzzle's validity. For the OECD and net capital-importing countries, the puzzle seems to have faded away in the build-up to the crisis, with largely insignificant and near-zero saving-retention coefficients in 2004-08. But this has reversed since the crisis. The findings match the hypothesis of international capital movement causing financial crises (Reinhart and Rogoff, 2009).

Importantly, net capital-exporters and importers experienced capital volatility to different extents. The saving-retention coefficient for net capital-importing countries became

more statistically irrelevant pre crisis, then faced an even more sobering bounce-back post 2008. Therefore, the effects can be said to be asymmetric in magnitude. Two striking impressions have arisen from the analysis. First, an unusually low β pre crisis preceded a high saving-investment correlation post crisis. This is evident across country groups. Second, the net capital-importing subgroup which has a more fluctuating β comprises countries hardest hit by the crisis. They include Greece, Iceland, Ireland, Italy, Spain and Portugal. Could a remarkable decline of β be an early warning signal? Also after the crisis has hit, are there policies that governments may consider to alleviate the necessary recession?

In this light, the OECD experience of the FH puzzle can be a lesson to both macroprudential and fiscal policymakers, in that order. This reflects the relative importance of preventing an excessive retreat of capital. From a macroprudential viewpoint, this paper is not to judge that a low β is bad *per se* – it merely reflects a wider array of investment opportunities. But what macroprudential policymakers have to be careful about are the possible financial inter-linkages built up in the period of low saving-investment correlation. If these inter-linkages are proved to be systemic, as in the case of the recent crisis, failure in one region can be contagious. Clearly, in the aftermath of a crisis, short-term capital control measures can be beneficial to countries which would otherwise have seen substantial capital outflows. Having closely followed the unfolding of events, the IMF (2012) adopted a shift in its institutional view on capital controls. It argued that countries may benefit from placing short-term capital controls to counter disruptive outflows which may cause market panic and currency depreciation.

However, arguably macroprudential policymakers should take a more ex-ante view. This study shows that OECD countries should have placed these short-term capital control measures before the crisis hit in 2008. The low saving-investment correlation can be an early warning indicator. When the OECD β loses its significance and drops to record lows, a closer

look into the financial linkages between countries could be warranted. Tighter stress tests for lending institutions can be a first step. If low βs persist, short-term capital controls could be considered by central bankers to combat a possibly sharp reversion in beta. This is particularly true for countries that have a history of net capital imports. For these countries, a low β can be seen as a precursor to a pick-up later on. A more forward-looking view can prevent such fluctuation. Nevertheless, the cyclicality of the saving-retention coefficient established in this study may not apply to all other crises. This is left as a potential area for future research.

This study has aimed to shed light on the following questions: Is the FH puzzle still a puzzle? Did the recent financial crisis affect the puzzle's validity in the OECD and are the effects asymmetric across OECD countries? While the first question has been attempted many times in the literature, the second and third are as far as we know original to this paper. The short answer to all of them is yes. Using beta as a warning signal is preventative. But there are also options for fiscal policymakers to consider once a crisis hits. For both the OECD and other subgroups, post-crisis saving-investment correlations are largely statistically significant, ranging from 0.29 to 0.54. If domestic investment is a crucial driver of growth in an economy (e.g. Korea in Section 4.1), the government can encourage saving. Through the relationship established between saving and investment, an extra unit of saving can deliver as much as 54% of investment channelled back to the domestic economy. This recommendation was first documented in the original seminal paper by FH (1980), but is equally applicable in a crisis environment where β has been generally picking up.

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Table 1a – Cross-section averages of annual data from 1980 to 2012				
Country	I/Y (%)	S/Y (%)	$I/Y - S/Y$ (%)	Net capital-exporting or net capital-importing?
Australia	26.21	21.50	4.71	Net capital-importing
Austria	24.38	24.19	0.19	Net capital-importing
Belgium	21.22	22.57	-1.35	Net capital-exporting
Canada	21.72	20.18	1.54	Net capital-importing
Denmark	19.70	21.34	-1.64	Net capital-exporting
Finland	22.23	23.28	-1.05	Net capital-exporting
France	19.59	19.62	-0.03	Net capital-exporting
Germany	21.55	22.53	-0.98	Net capital-exporting
Greece	21.77	16.17	5.6	Net capital-importing
Hungary	24.07	20.43	3.64	Net capital-importing
Iceland	21.07	15.96	5.11	Net capital-importing
Ireland	20.52	18.85	1.67	Net capital-importing
Israel	21.82	19.46	2.36	Net capital-importing
Italy	21.39	20.20	1.19	Net capital-importing
Japan	26.42	28.81	-2.39	Net capital-exporting
Korea	31.77	32.99	-1.22	Net capital-exporting
Luxembourg	21.17	28.97	-7.8	Net capital-exporting
Mexico	23.85	22.22	1.63	Net capital-importing
Netherlands	20.84	25.48	-4.64	Net capital-exporting
New Zealand	21.74	16.93	4.81	Net capital-importing
Norway	23.63	30.37	-6.74	Net capital-exporting
Portugal	26.49	20.23	6.26	Net capital-importing
Spain	24.06	21.13	2.93	Net capital-importing
Sweden	18.94	21.54	-2.6	Net capital-exporting
Turkey	21.35	19.09	2.26	Net capital-importing
United Kingdom	17.43	15.95	1.48	Net capital-importing
United States	21.89	18.87	3.02	Net capital-importing
The classification of net capital-exporting and –importing of a country is based on the difference between its average investment and saving rates taken across the 33-year period.				

Table 2b – Cross-section averages of annual data from 1980 to 2012 (continued)			
Country	Number of years net capital-exporting	Satterthwaite-Welch t-statistic	Wilcoxon/Mann-Whitney t-statistic
Australia	0	9.13***	6.19***
Austria	14	0.45	0.40
Belgium	23	-2.08**	2.24**
Canada	11	2.49**	2.14**
Denmark	22	-3.11***	2.64***
Finland	17	-1.08	1.23
France	15	-0.084	0.00
Germany	15	-1.58	1.06
Greece	0	6.33***	5.44***
Hungary	5	3.87***	3.54***
Iceland	8	3.51***	3.16***
Ireland	12	1.53	1.46
Israel	12	2.99***	1.85*
Italy	8	2.68***	2.42**
Japan	32	-2.59**	2.25**
Korea	20	-1.34	1.82*
Luxembourg	28	-6.22***	4.87***
Mexico	4	2.30**	1.86*
Netherlands	32	-10.42***	6.62***
New Zealand	0	8.46***	6.12***
Norway	28	-6.22***	4.96***
Portugal	2	4.52***	3.73***
Spain	3	4.69***	3.66***
Sweden	22	-3.54***	3.37***
Turkey	5	2.81***	2.35**
United Kingdom	4	3.47***	2.95***
United States	0	6.23***	5.05***

The number of years a country's saving rate exceeds its investment rate. * Significant at 10% ** Significant at 5% *** Significant at 1%. Satterthwaite-Welch and Wilcoxon/Mann-Whitney t-statistics have the null hypothesis of equality of the means and medians, respectively, between I/Y and S/Y for each sample country.

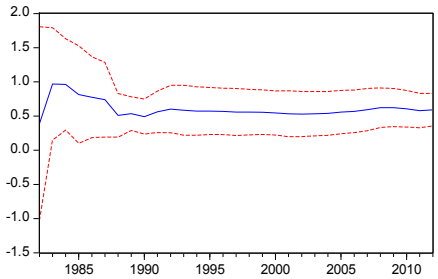
Table 2 – Panel estimations for the OECD						
Estimation technique	Time period	Constant	$(S/Y)_{it}$	$(S/Y)_{it} * t$	*R-squared*	Hausman test *(p-value)*
Pooled OLS	Historical (1980-2003)	12.01*** (2.17)	0.57*** (0.10)	-0.0066*** (0.0012)	*0.41*	-
	5 years prior to crisis (2004-08)	23.10*** (2.12)	-0.35** (0.16)	0.013*** (0.0039)	*0.015*	-
	5 years post crisis (2008-12)	14.89*** (1.29)	0.75*** (0.21)	-0.016** (0.020)	*0.27*	-
Fixed Effects (FE)	Historical (1980-2003)	14.20*** (0.95)	0.47*** (0.04)	-0.0059*** (0.0012)	*0.71*	-
	5 years prior to crisis (2004-08)	17.36*** (1.79)	-0.18 (0.15)	0.016*** (0.0032)	*0.90*	-
	5 years post crisis (2008-12)	19.15*** (5.47)	0.59* (0.31)	-0.017** (0.0075)	*0.75*	-
Random Effects (RE)	Historical (1980-2003)	13.93*** (0.98)	0.48*** (0.047)	-0.0059*** (0.0012)	*0.32*	*0.0069*
	5 years prior to crisis (2004-08)	19.15*** (1.56)	-0.26** (0.13)	0.016*** (0.0031)	*0.20*	*0.0002*
	5 years post crisis (2008-12)	16.16*** (2.06)	0.71*** (0.22)	-0.016** (0.0066)	*0.12*	*0.23*
* Significant at 10% ** Significant at 5% *** Significant at 1%. White-period standard error in parenthesis. The Hausman test is based on ordinary coefficient covariance method as robust standard errors may be inconsistent with Hausman test variance calculation assumptions.						

Table 3 – Panel estimations for net capital-exporting countries						
Estimation technique	Time period	Constant	$(S/Y)_{it}$	$(S/Y)_{it} * t$	*R-squared*	Hausman test *(p-value)*
Pooled OLS	Historical (1980-2003)	7.21** (3.06)	0.76*** (0.14)	-0.0097*** (0.0015)	*0.60*	-
	5 years prior to crisis (2004-08)	13.92*** (4.02)	-0.14 (0.25)	0.016*** (0.0036)	*0.25*	-
	5 years post crisis (2008-12)	11.56*** (3.27)	0.59** (0.24)	-0.0074 (0.0055)	*0.35*	-
Fixed Effects (FE)	Historical (1980-2003)	13.25*** (1.53)	0.49*** (0.073)	-0.0080*** (0.0019)	*0.81*	-
	5 years prior to crisis (2004-08)	14.56*** (1.38)	-0.21* (0.12)	0.018*** (0.0031)	*0.96*	-
	5 years post crisis (2008-12)	7.92** (3.17)	0.69*** (0.21)	-0.0057 (0.0068)	*0.90*	-
Random Effects (RE)	Historical (1980-2003)	12.27*** (1.55)	0.53*** (0.082)	-0.0082*** (0.0018)	*0.42*	*0.0003*
	5 years prior to crisis (2004-08)	14.49*** (1.19)	-0.21* (0.12)	0.018*** (0.0028)	*0.64*	*0.39*
	5 years post crisis (2008-12)	8.99*** (2.43)	0.65*** (0.20)	-0.0061 (0.0058)	*0.40*	*0.51*
See Table 2's footnote.						

Table 4 – Panel estimations for net capital-importing countries						
Estimation technique	Time period	Constant	$(S/Y)_{it}$	$(S/Y)_{it} * t$	*R-squared*	Hausman test *(p-value)*
Pooled OLS	Historical (1980-2003)	10.25*** (1.63)	0.66*** (0.073)	-0.0034*** (0.0016)	*0.38*	-
	5 years prior to crisis (2004-08)	22.75*** (2.84)	-0.13 (0.21)	0.0069 (0.0058)	*0.0096*	-
	5 years post crisis (2008-12)	13.66*** (1.90)	1.19*** (0.44)	-0.026* (0.014)	*0.34*	-
Fixed Effects (FE)	Historical (1980-2003)	13.92*** (1.17)	0.48*** (0.049)	-0.0037** (0.0015)	*0.61*	-
	5 years prior to crisis (2004-08)	19.25*** (1.87)	-0.13 (0.22)	0.014** (0.0058)	*0.85*	-
	5 years post crisis (2008-12)	23.88*** (4.56)	0.70 (0.56)	-0.030** (0.015)	*0.73*	-
Random Effects (RE)	Historical (1980-2003)	13.46*** (1.20)	0.51*** (0.043)	-0.0036** (0.0014)	*0.29*	*0.032*
	5 years prior to crisis (2004-08)	20.30*** (1.99)	-0.15 (0.20)	0.013** (0.0052)	*0.10*	*0.046*
	5 years post crisis (2008-12)	16.11*** (2.54)	1.11** (0.44)	-0.028** (0.014)	*0.14*	*0.0007*
See Table 2's footnote.						

Figure 1 – Summary of recursive estimation results

Australia



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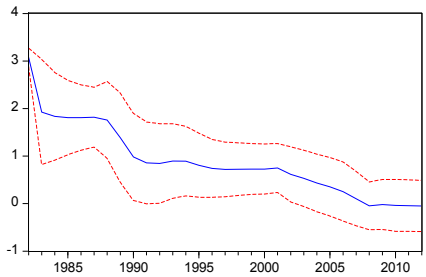

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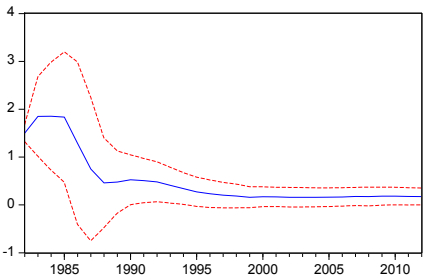

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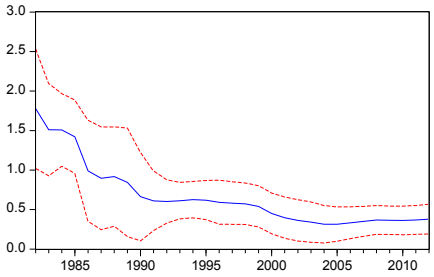

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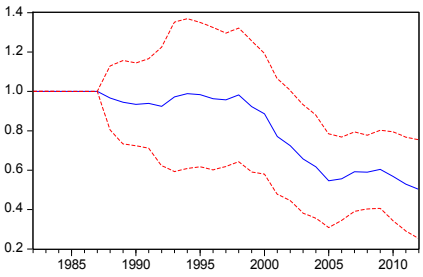

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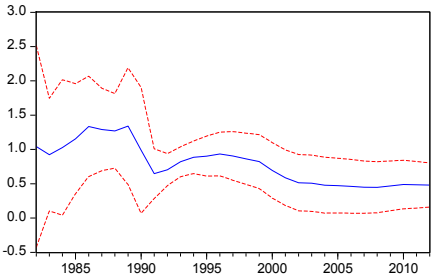

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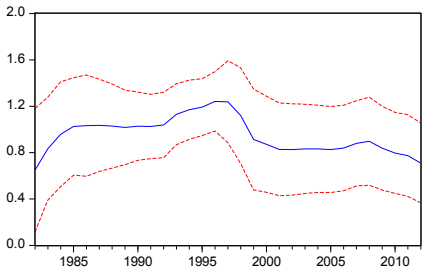

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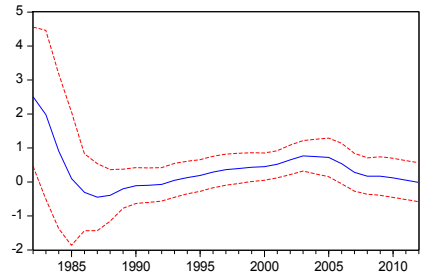
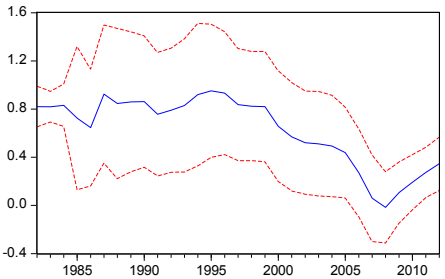


Greece



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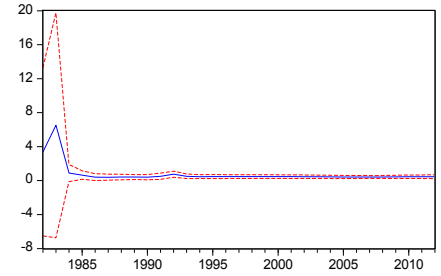

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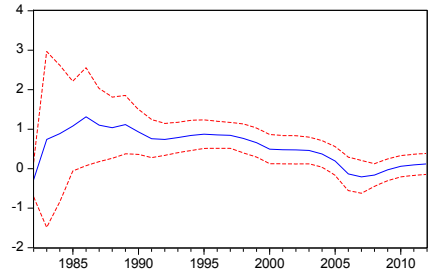

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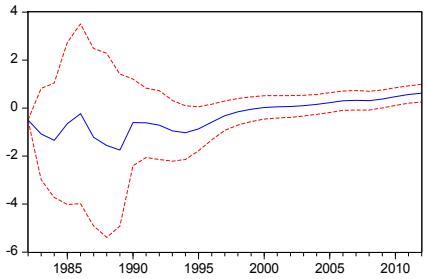

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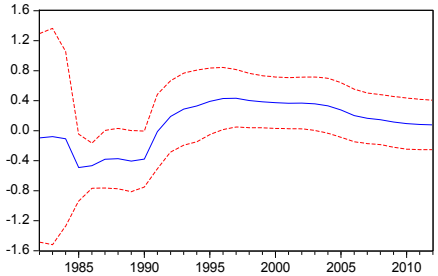
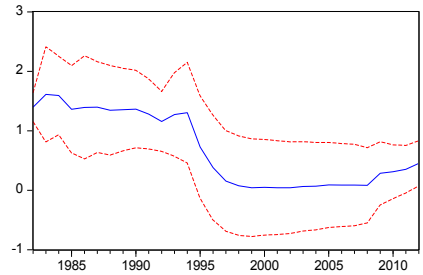
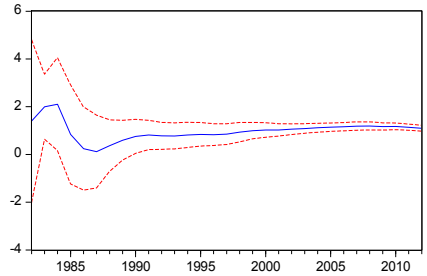


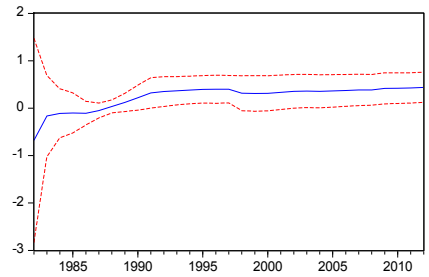
Italy



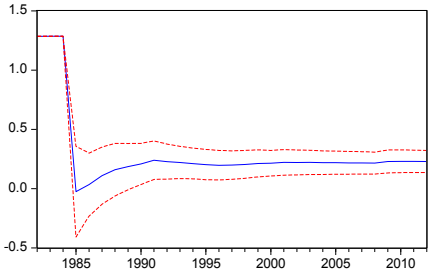
Japan



Korea



Luxembourg



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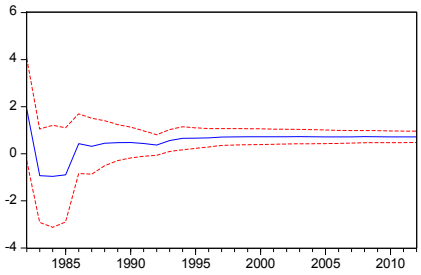
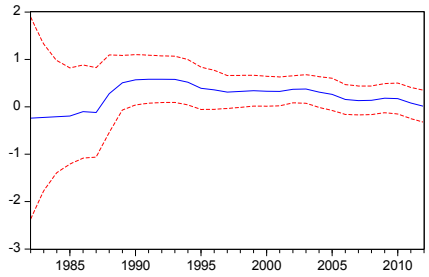
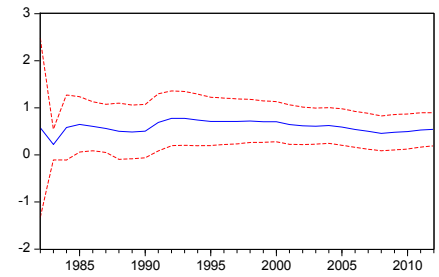


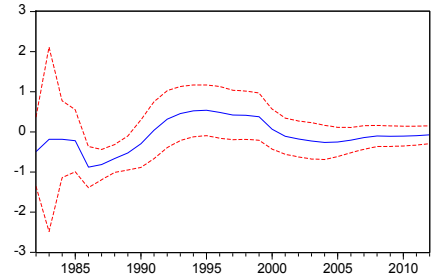
Netherlands



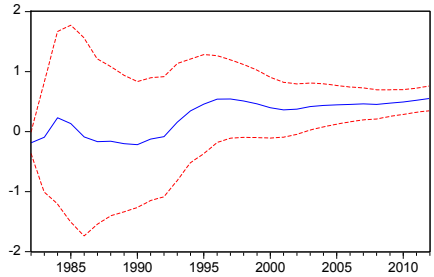
New Zealand



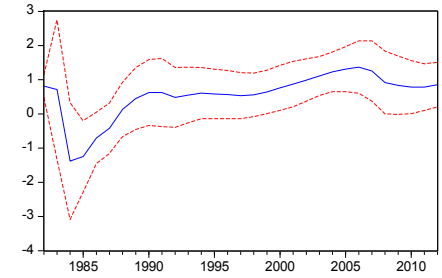
Norway



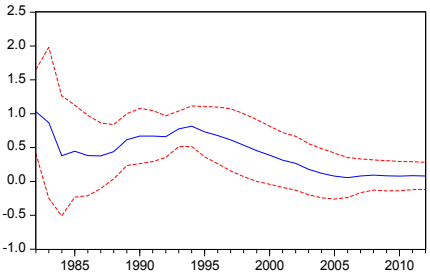
Portugal



Spain



Sweden



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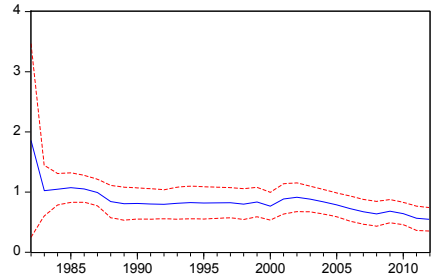
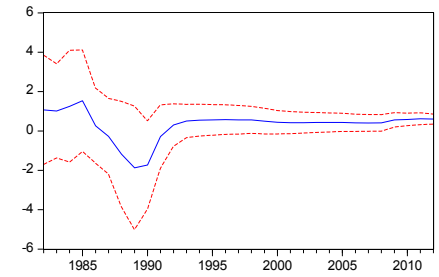


United Kingdom



United States